ARS 857 (2012) (English): Finger millet grains — Specification

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Finger millet grains — Specification

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Foreword

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This African Standard was prepared by the ARSO Technical Harmonization Committee on Agriculture and Food Products (ARSO/THC 1).

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Introduction

Finger millet (*Eleusine coracana*) is one of the few special species that currently support the world's food supplies and its annual world production is at least 4.5 million tons of grain, of which Africa produces perhaps 2 million tons.

Of all major cereals, this crop is one of the most nutritious. Indeed, some varieties appear to have high levels of methionine, an amino acid lacking in the diets of hundreds of millions of the poor who live on starchy foods such as cassava and plantain. Its grain tastes better than most; Africans who know it usually prefer finger millet over all others. The plant is also productive and thrives in a variety of environments and conditions. Moreover, its seeds can be stored for years without insect damage, which makes them lifesavers for famine-prone areas.

This is a versatile grain that can probably be used in dozens of types of foods, including many that are quite unlike its traditional ones. Its several major uses include the following:

— Porridge. The small grains—which are usually brown but occasionally white—are commonly boiled into a thick porridge.

— Bread. Some finger millet is ground into flour and used for bread and various other baked products. All are relished for their flavour and aroma.

— Malt. Malted finger millet (the sprouted seeds) is produced as a food in a few places. It is nutritious, easily digested, and is recommended particularly for infants and the elderly.

— Beverages. Much finger millet in Africa is used to make beer. Its amylase enzymes readily convert starch to sugar. Indeed, finger millet has much more of this "saccharifying" power than does sorghum or maize; only barley, the world's premier beer grain, surpasses it. In Ethiopia, finger millet is also used to make arake, a powerful distilled liquor.

— Fodder. Finger millet straw makes good fodder—better than that from pearl millet, wheat, or sorghum. It contains up to 61 per cent total digestible nutrients.

— Popped Products. Finger millet can be popped. It is widely enjoyed in this tasty form in India.

The grain's protein content (7.4 per cent) is comparable to that of rice (7.5 per cent). However, it shows considerable variation, and at least one Indian cultivar contains as much as 14 per cent protein.

The main protein fraction (eleusinin) has high biological value, with good amounts of tryptophan, cystine, methionine, and total aromatic amino acids (Total aromatic acids" is the combination of phenylalanine and tyrosine). All of these are crucial to human health and growth and are deficient in most cereals. For this reason alone, finger millet is an important preventative against malnutrition. The methionine level—ranging around 5 per cent of protein—is of special benefit, notably for those who depend on plant foods for their protein.

Finger millet is also a rich source of minerals. Some samples contain 0.33 percent calcium, 5-30 times more than in most cereals. The phosphorus and iron content can also be high.

This African Standard has been prepared to facilitate trade in finger millet grains as a means of achieving food security and nutrition in Africa.

Finger millet grains — Specification

1 Scope

This African Standard specifies the requirements and methods of sampling and test for finger millet grains of varieties (cultivars) grown from *Eleusine coracana* (L.) Gaertner intended for human consumption, i.e., ready for its intended use as human food, presented in packaged form or sold loose from the package directly to the consumer. It does not apply to other products derived from finger millet grains.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ARS 53, *General principles of food hygiene — Code of practice*

ARS 56, *Prepackaged foods — Labelling*

CODEX STAN 193, *Codex general standard for contaminants and toxins in food and feed*

ISO 605*, Pulses — Determination of impurities, size, foreign odours, insects, and species and variety — Test methods*

ISO 711, *Cereals and cereal products — Determination of moisture content (Basic reference method)*

ISO 712*, Cereals and cereal products — Determination of moisture content — Routine reference method*

ISO 5223, *Test sieves for cereals*

ISO 5984, *Animal feeding stuffs — Determination of crude ash*

ISO 6579, *Microbiology of food and animal feeding stuffs — Horizontal method for the detection of Salmonella* spp.

ISO 6639-1, *Cereals and pulses — Determination of hidden insect infestation — Part 1: General principles*

ISO 6639-2, *Cereals and pulses — Determination of hidden insect infestation — Part 2: Sampling*

ISO 6639-3, *Cereals and pulses — Determination of hidden insect infestation — Part 3: Reference method*

ISO 6639-4, *Cereals and pulses — Determination of hidden insect infestation — Part 4: Rapid methods*

ISO 6888-1, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) — Part 1: Technique using Baird-Parker agar medium*

ISO 6888-2, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) — Part 2: Technique using rabbit plasma fibrinogen agar medium*

ISO 6888-3, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of coagulase-positive staphylococci (Staphylococcus aureus and other species) — Part 3: Detection and MPN technique for low numbers*

ISO 7251, *Microbiology of food and animal feeding stuffs — Horizontal method for the detection and enumeration of presumptive Escherichia coli — Most probable number technique*

ISO 24333, *Cereals and cereal products — Sampling*

ISO 16050, *Foodstuffs — Determination of aflatoxin B_1, and the total content of aflatoxin B_1, B_2, G_1 and G_2 in cereals, nuts and derived products — High performance liquid chromatographic method*

ISO 20483, *Cereals and pulses — Determination of the nitrogen content and calculation of the crude protein content — Kjeldahl method*

ISO 21527-2, *Microbiology of food and animal feeding stuffs — Horizontal method for the enumeration of yeasts and moulds — Part 2: Colony count technique in products with water activity less than or equal to 0.95*

3 Definitions

For the purpose of this standard the following definitions apply.

3.1
finger millet grain
dried grain having the characteristics of the species *Eleusine coracana* (L.) Gaertner

3.2
whole grains
grains of finger millet obtained after proper threshing with no mechanical treatment

3.3
foreign matter
all organic and inorganic material other than sorghum, broken kernels, other grains and filth. Foreign matter includes loose sorghum seed coats.

3.4
other edible grains
any edible grains (including oil seeds) other than the one which is under consideration

3.5
damaged grains
grains that are sprouted or internally damaged as a result of heat, microbe, moisture or weather

3.6
immature and shrivelled grains
grains that are not properly developed

3.7
weevilled grains
grains that are partially or wholly bored by insects injurious to grains but does not include germ eaten grains and egg spotted grains

3.8
poisonous, toxic and/or harmful seeds
any seed which if present in quantities above permissible limit may have damaging or dangerous effect on health, organoleptic properties or technological performance such as Jimson weed — Datura (*D. fastuosa* Linn and *D. stramonium* Linn.) corn cokle (*Agrostemma githago* L., *Machai Lallium remulenum* Linn.) Akra (Vicia species), *Argemone mexicana*, Khesari and other seeds that are commonly recognized as harmful to health

4 Quality requirements

4.1 General requirements

4.1.1 Finger millet shall meet the following general requirements/limits as determined using the relevant standards listed in Clause 2:

a) shall be the dried mature grains of *Eleusine coracana* (L.) Gaertner;

b) shall be hard, clean, wholesome, uniform in size, colour and in sound merchantable condition;

c) shall be safe and suitable for human consumption;

d) shall be free from abnormal flavours, obnoxious smell and discolouration.

e) shall be free from micro-organisms and substances originating from micro-organisms or other poisonous or deleterious substances in amounts that may constitute a hazard to human health.

4.1.2 Finger millet grains shall be in form of well-filled seeds of uniform colour.

4.2 Specific requirements

4.2.1 Grading

Finger millet may be graded into three grades on the basis of the tolerable limits established in Table 1 which shall be additional to the general requirements set out in this standard.

Table 1 — Specific requirements

Characteristic		**Grade**			**Method of test**
		1	2	3	
Foreign matter, whole grains, % by mass, *max*.	Organic	0.25	0.50	0.75	ISO 605
	Inorganic	0.10	0.25	0.25	
Other edible grains, % by mass, *max*.		1.5	2.0	4.0	
Damaged grain, % by mass, *max.*		2.0	3.0	5.0	
Immature and shrivelled, % by mass, *max.*		3.0	4.0	4.0	
Weevilled grains per cent by count		0.2	0.3	0.5	
Moisture content, % m/m, max		12.0	13.0	14.0	ISO 711/712
Crude protein, % by dry mass basis, *min*		8.0			ISO 20483
Ergot affected grains %m/m		0.05			Annex A
1000 Kernel weight, g					
Whole millet grains		5.0 to 10.0			Undefined
Decorticated millet grains		4.0 to 8.0			Undefined
1 litre weight, g		750 to 820			Undefined
Decortication %m/m max		20			Undefined
Fat content, % by dry mass basis		3.5 to 6.0			ISO 5986
Tannin content, % by mass, *max.*		0.5			ISO 9648
Crude fibre, % by dry mass basis:		3.0 to 4.5			ISO 5498
Total aflatoxin (AFB1+AFB2+AFG1 +AFG2)), ppb, max		10			ISO 16050
Aflatoxin B1 only, ppb max		5			
Fumonisin ppm max		2			

NOTE **Foreign matter** is mineral or organic matter (dust, twigs, seedcoats, seeds of other species, dead insects, fragments, or remains of insects, other impurities of animal origin). Finger millet grains shall have not more than 1% extraneous matter of which not more than 0.25% shall be mineral matter and not more than 0.10% shall be dead insects, fragments or remains of insects, and/or other impurities of animal origin.

4.2.2 Ungraded finger millet

Ungraded finger millet grains shall be finger millet grains which do not fall within the requirements of Grades 1, 2 and 3 of this standard but meet the minimum requirements provided in 4.1 and are not rejected finger millet grains. Ungraded finger millet grains can be sorted out to Grade 1, 2 or 3 in accordance with the relevant grading procedures.

4.2.3 Reject grade finger millet

This comprises finger millet grains which have objectionable odour, off flavour, living insects or which do not possess the quality characteristics specified in Table 1. They cannot satisfy the conditions of ungraded finger millet grains and shall be classified as reject finger millet grains and shall be condemned as unfit for human consumption.

5 Contaminants

5.1 Heavy metals

Finger millet grains shall comply with those maximum limits for heavy metals established by the Codex Alimentarius Commission for this commodity.

5.2 Pesticide residues

Finger millet grains shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission for this commodity.

5.3 Mycotoxin limits

Finger millet grains shall comply with those maximum mycotoxin limits established by the Codex Alimentarius Commission for this commodity. In particular, total aflatoxin levels in finger millet grains for human consumption shall not exceed 10 µg/kg (ppb) with B_1 not exceeding 5 µg/kg (ppb) when tested according to ISO 16050.

6 Hygiene

6.1 Finger millet shall be produced, prepared and handled in accordance with the provisions of appropriate sections of ARS 53.

6.2 When tested by appropriate standards of sampling and examination listed in Clause 2, the products:

— shall be free from microorganisms in amounts which may represent a hazard to health and shall not exceed the limits stipulated in Table 2;

— shall be free from parasites which may represent a hazard to health; and

— shall not contain any substance originating from microorganisms in amounts which may represent a hazard to health.

Table 2 — Microbiological limits

	Type of micro-organism	Limits	Test method
i)	Yeasts and moulds, max. per g	10^4	ISO 21527-2
ii)	*S. aureus* per 25 g	Not detectable	ISO 6888
iii)	*E. Coli*, max. per g	Not detectable	ISO 7251
iv)	*Salmonella,* max. per 25 g	Not detectable	ISO 6579

7 Packaging

7.1 Finger millet grains shall be packed in gunny bags/jute bags, poly woven bags, poly pouches, cloth bags or other suitable packages which shall be clean, sound, free from insect, fungal infestation and the packing material shall be of food grade quality.

7.2 Finger millet grains shall be packed in containers which will safeguard the hygienic, nutritional, technological and organoleptic qualities of the products.

7.3 The containers, including packaging material, shall be made of substances which are safe and suitable for their intended use. They shall not impart any toxic substance or undesirable odour or flavour to the product.

7.4 Each package shall contain finger millet grains of the same type and of the same grade designation.

7.5 If finger millet grains are presented in bags, the bags shall also be free of pests and contaminants

7.6 Each package shall be securely closed and sealed.

8 Marking or labelling

8.1 In addition to the requirements in ARS 56, each package shall be legibly and indelibly marked with the following:

i) product name as “Whole Finger Millet Grains” or “Decorticated Finger Millet Grains;

ii) variety;

iii) grade;

iv) name, address and physical location of the producer/ packer/importer;

v) lot/batch/code number;

vi) net weight, in kg;

vii) the declaration “Food for Human Consumption’’;

viii) storage instruction as “Store in a cool dry place away from any contaminants’’;

ix) crop year;

x) packing date;

xi) instructions on disposal of used package;

xii) country of origin;

xiii) a declaration on whether the finger millet was genetically modified or not.

9 Sampling

Sampling shall be done in accordance with the requirements of ISO 24333.

Annex A
(normative)

Determination of ergot

A.1 Test for presence of ergot in food grains

A.1.1 Reagents

(a) **Petroleum ether** — 40 – 60 °C

(b) **Solvent ether**

(c) **Dilute Ammonia** 10 % (v/ v)

(d) **Tartaric acid solution** — 1 % (freshly prepared)

(e) **p-dimethyl amino benzaldehyde (PDAB)** — Dissolve 0.125 gm of PDAB in a cold mixture of 65 ml of conc sulphuric acid and 35 ml of distilled water.

Add 0.1 ml of 5 % Ferric chloride solution and let it stand for 24 hours before use.

A.1.2 Apparatus

(a) Grinding mill

(b) Electric shaker

A.1.3 Procedure

Grind about 50 gm of sample in the grinding mill to a fine powder. Take 10 gm of powdered sample in a stoppered conical flask. Add sufficient petroleum ether and shake for half an hour in the electric shaker. Allow to settle and decant off the petroleum ether. Dry the material in air. Add to the material 8 ml of dilute ammonia and sufficient quantity of solvent ether. Again shake for ½ hour. Filter ether portion in a beaker and concentrate to a small volume. Add 2 ml of tartaric acid solution to the beaker and shake thoroughly. Mix 1 ml of this tartaric acid – sample solution with 1 or 2 ml of p-dimethyl benzaldehyde solution.

The appearance of blue colour indicates presence of ergot.

A.2 Determination of quantity of ergot (*Claviceps purpurea* Tul.)

A.2.1 Objective and field of application

The method is used for both qualitative and quantitative determination of ergot in food and feed. The method is suitable for the examination of food and feed of different particle sizes. In pelleted feedingstuff only qualitative determination is possible.

A.2.2 Principle

Ergot in food and feed is determined by the macroscopic and microscopic identification of the ergot sclerotia and fragments. Quantification is done by weighing the amount of identified sclerotia and fragments with a particle size >0.5 mm.

A.2.3 Reagents

A.2.3.1 Chloral hydrate, β = 60%

A.2.3.2 Sodium hydroxide (pelleted)

A.2.3.3 Potassium hydroxide (pelleted)

A.2.3.4 Ethanol, σ = 50%

A.2.3.5 Acetone

The reagents listed can be replaced by others which produce comparable results.

A.2.4 Equipment and accessories

A.2.4.1 Optical equipment

A.2.4.1.1 Stereo microscope (up to 70x magnification)

A.2.4.1.2 Magnifier (up to 10x magnification)

A.2.4.2 Mortar and pestle

A.2.4.3 Sieves fitted with wire nettings or perforations with different mesh sizes (e.g. 2.0 mm, 1.0 mm, 0.5 mm, 0.25 mm) and collecting tray; recommended additional equipment: sieve towers, sieve shaker

A.2.4.4 Analytical balance (accuracy 0.001 g)

A.2.4.5 Oven (up to 130 °C)

A.2.4.6 Laboratory glassware

A.2.4.7 Filters (e.g. paper, gaze)

A.2.4.8 Freeze dryer

A.2.4.9 Hot plate or Bunsen burner

A.2.4.10 Reference material

A.2.5 Procedure

The examination is performed in non-pelleted food and feed. Pelleted food and feed have to be depelleted before examination (A.2.4.2; A.2.8.1).

Qualitative determination of the sclerotia is performed macroscopically and microscopically considering ergot and its fragments in both the sieve fraction >0.5mm and < 0.5mm.

Quantification is performed by selecting and weighing of ergot and its fragments with a particle size >0.5mm out of the laboratory sample or an aliquot of it.

A.2.5.1 Preparation of the laboratory sample

A.2.5.1.1 Whole kernel feedingstuff (at least 250g) are weighed (A.2.4.4) and used directly for the investigation (A.2.5.2 and A.2.5.3).

A.2.5.1.2 Non-pelleted feedingstuff (at least 10g) are weighed (A.2.4.4) and fractionated bysieving. The obtained fractions > 0.5mm and ≤ 0.5mm are weighed (A.2.4.4).

A.2.5.2 Identification of ergot

Ergot sclerotia are identified based on their characteristic features. The identification may be facilitated by comparison to reference material (A.2.4.10) and existing descriptions.

Morphology: *Ergot sclerotia* Tul. are elongated with a length up to several centimetres, coloured dark violet to black. The shape is similar to cereal kernels. They only consist of fungal hyphae.

Anatomy: Cross sections through the random parts of ergot sclerotia show very small, narrow interconnected hyphae which yield a dense pseudoparenchymatic tissue. The cells contain lots of fat oil. The outer layers of the hyphae are coloured dark violet to black, whereas the inner parts are coloured light pink to violet.

For the identification of ergot fragments in the sieve fractions <0.5mm the following colour reaction can be used. This staining procedure is only applicable to fresh sclerotia material.

A filter paper is soaked with a solution of 3ml ethanol (A.2.3.4) and 2 sodium hydroxide pellets (A.2.3.2) or 2 potassium hydroxide pellets (A.2.3.3). The sample is distributed on the filter paper.

After app. 5 min. a red-violet halo around the ergot fragments is observed.

The dark violet colouring of the outer hyphae layers is dissolved also in chloralhydrate (A.2.3.1) and colours it violet.

A.2.5.3 Quantification

The quantification of ergot is performed using the sieve fractions > 0.5 mm.

Material identified as ergot in each fraction is selected and weighed. An aliquot of the sieved fractions may be used if necessary. The ergot content of the fractions >0.5mm is summarized and expressed in mg/kg feedingstuff (A.2.6.1).

A.2.6 Calculation and report

A.2.6.1 Calculation

The amount of ergot fragments in mg/kg (ppm) feedingstuff (original sample) is calculated using the following formula:

$$C = \frac{BC \times 1000}{E} \text{ [mg/kg]}$$

C = amount of component in mg/kg feedingstuff (ppm)

BC = selected fragments of component in the laboratory sample or an aliquot of it [mg]

E = total weight of the laboratory sample or an examined aliquot of the laboratory sample [g]

A.2.6.2 Report

A.2.6.2.1 Negative result:

As far as was discernible using a microscope, ergot was not found in the submitted sample.

A.2.6.2.2 Positive result:

As far as was discernible using a microscope xx mg ergot/kg feedingstuff were found in the submitted sample. For quantification ergot particles >0.5 mm are considered.

A.2.6.2.3 Possible adding to the report:

In pelleted feedingstuff only qualitative determination of ergot is possible.

A.2.8 Remarks

A.2.8.1 For the identification of ergot in pelleted feedingstuffs, the sample is depleted using either of the following procedures:

(a) At least 10 g of the pressed material is mixed with at least three times as much water. The suspension is stirred up several times and left standing until the pellets disintegrate. Then the depelletised material is filtered (A.2.4.7) and dried at room temperature or freeze-dried (A.2.4.8).

(b) For depelletising at high humidity pressed material (at least 10 g) is left standing in humid atmosphere at 70 °C (A.2.4.5) until the pellets disintegrate. The material is crushed, sieved (A.2.4.3) and dried at room temperature immediately to prevent the particles from sticking together again.

A.2.8.2 Ergot are the permanent forms or sclerotia of ergot which mainly occur in rye, more seldom in wheat, triticale and barley.

A.2.8.3 This method also is suitable for the examination of raw material and food.

Bibliography

EAS 758:2011, *Finger millet grains — Specification*